



## Predictive modeling of stream ecosystem processes: can we assess the integrity of stream ecosystems directly?

### Overview

The Clean Water Act (CWA) of 1972 provides a mandate to “restore and maintain the chemical, physical and biological integrity of the Nation’s waters.”

- Despite 32 years of the CWA, freshwater ecosystems remain highly endangered.

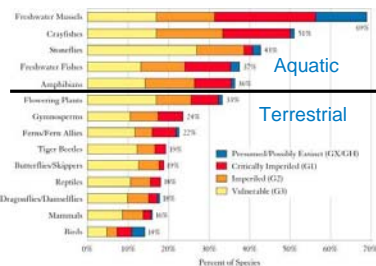
- Streams ecosystems provide a variety of essential ecosystem services (e.g., water purification, supporting fish populations).

- Recently, more emphasis has been placed on the biological, rather than the strictly chemical, components of water quality.

- All biological assessments of water quality focus on measuring various aspects (indicators) of the stream community (fish and/or macroinvertebrates) and using the results to infer the degree to which biological integrity has been retained.

- While we suspect that there is a relationship between the state of the biological community and the degree to which critical stream ecosystem processes remain intact, the question has never been directly addressed.

- The overall aim of my research is to answer this question.



### Research Strategy

I use the Reference Condition Approach (RCA) to evaluate whether there is a correlation between biological integrity as estimated using species composition and ecosystem function as estimated using leaf litter decomposition rates. Leaf litter decomposition is a critical ecosystem process in streams.



#### The Reference Condition Approach

The RCA involves 4 basic steps:

- 1) Measure the value of a biological indicator at a large number of relatively pristine (“reference”) streams to quantify the range of natural variability.
- 2) Use multivariate statistics in combination with environmental data to generate a range of expected values for the indicator in the absence of impairment.
- 3) Compare the indicator value observed at the stream you’re interested in with the expected range of values.
- 4) If the observed value falls outside of the range predicted to occur in the absence of impairment, we infer that the stream is biologically impaired.

- Macroinvertebrate data have been collected from over 200 reference streams and 250 grazed streams in Montana, Idaho, Wyoming and Utah.

- I used the RCA to develop a statistical model that predicts the macroinvertebrate species composition of unimpaired streams from their environmental characteristics.



- The model indicates that 51% of the grazed streams are biologically impaired (i.e., their Species compositions are significantly different from that expected in the absence of impairment).



### What about ecosystem function?

- I measured leaf litter decomposition rates in 48 of the reference streams and 15 of the grazed streams.

- Decomposition rates vary substantially between streams, with no overall differences between grazed and ungrazed (reference), or between impaired and unimpaired streams.

- Although environmental data can account for 65% of the natural variability among reference streams, that is not sufficient to allow the prediction of decomposition rates.

**Based on these preliminary results, we cannot conclude that biological assessments provide an accurate assessment of ecosystem function.**

- More data are needed to determine whether we can use the RCA to assess directly the functional integrity of stream ecosystems.



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